Reply to "Comment on 'Background thermal contributions in testing the Unruh effect' "

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Abstract

Park et al's recent comment that for detectors with large energy gap in comparison with the temperature of the background thermal bath, the maximum excitation rate is obtained for some non-zero detector's velocity is *correct* but was previously discussed by *ourselves* in [3], and does not affect in [2] *any* mathematical formula, numerical result, or our final conclusion that the background thermal bath does not contribute substantially in the depolarization of electrons at LEP.

Park et al's comment [1] that for detectors with large energy gap ΔE in comparison with the temperature β^{-1} of the background thermal bath, one should not state that the faster a detector moves the less it interacts with the background thermal bath, because the maximum excitation rate is obtained for some detector's velocity $v > 0$, is true but *does not affect in* [2] *any mathematical formula, numerical result, or our final conclusion that the background thermal bath does not contribute substantially in the depolarization of electrons at LEP.* In fact, as calculated in Sec. IV of [2] using a two-level scalar model for the electron, the *vacuum* contribution to the flip probability is three orders of magnitude larger than the *background thermal bath* contribution, because of the electron acceleration. This is consistent with Eq. (2.6) as discussed at the end of Sec. IV. For completeness we reproduce Eq. (2.6) of [2] below

$$\frac{\mathcal{P}^{\rm exc}}{T^{tot}} = \frac{c_0^2 \beta^{-1}\sqrt{1-v^2}}{4\pi v} \ln\left[\frac{1-e^{-\beta\Delta E\sqrt{1+v}/\sqrt{1-v}}}{1-e^{-\beta\Delta E\sqrt{1-v}/\sqrt{1+v}}}\right],$$

where $\mathcal{P}^{\rm exc}/T^{tot}$ is the excitation rate per proper time for inertial detectors moving in a background thermal bath with temperature β^{-1}, and ΔE, v were defined above. Moreover, we stress that Park et al's comment above, that for $\Delta E\beta >> 1$ the maximum excitation rate is obtained for some velocity $v > 0$ was *previously* stated by *ourselves* in Ref. [3] (see caption of Fig. 1), where Eq. (2.6) was comprehensively discussed in connection with the classical problem about *how temperature transforms under boosts*. Thus, it seems fair to say that the main (if not sole) contribution brought by Park et al's Comment is that the ΔE value in the caption of Fig. 1 of Ref. [2] has a misprint. We have used $\Delta E = 9.7 \times 10^{13}\ s^{-1}$ rather than $\Delta E = 9.7 \times 10^{14}\ s^{-1}$ to plot this figure (*and only this figure)* because of visual reasons.

In summary, Park et al's comment in [1] although correct was previously discussed by ourselves in [3], and does not affect in [2] any mathematical formula, numerical result, or our final conclusion that the background thermal bath does not contribute substantially in the depolarization of electrons at LEP.

ACKNOWLEDGMENTS

S.C. acknowledges full support by Fundação de Amparo à Pesquisa do Estado de São Paulo, while G.M. was partially supported by Conselho Nacional de Desenvolvimento Científico e Tecnológico.

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